GM-free private standards, public regulation of GM products and mass media

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Abstract. The paper analyses the factors inducing retailers to adopt GM-*free* private standards, using information of 44 retailers operating in 54 countries. Retailers are distinguished between those not using genetically modified (GM) ingredients and those using ingredients which are potentially GM in their private label products. Results from a binary response model show that many of the drivers highlighted in the empirical literature, such as historical factors, communication infrastructure and sectorial conditions, affect the likelihood of adopting GM-*free* private standards. Moreover, we test additional hypotheses from the political economy of standards formation and of mass media. Key results show that a higher share of government-oriented public media reduces the probability of adopting GM-*free* private standards, while different GMO public standards between home and operating countries increase this probability.

Key words: GM-free private standards, vertical differentiation, media market
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1. Introduction

In recent years, the adoption of private standards concerning product attributes significantly increased. Producers are increasingly asked to certify their products to comply with specific standards created by firms, standard setting coalitions (e.g. GFSI) and non-governmental organizations (NGOs). The goal of private standards is not only to specify the quality level and safety of food products (e.g. GlobalGAP, BRC, IFS), but also the attributes of the production process and its environmental and socio-economic effects (e.g. Rainforest Alliance and Fair trade). Retailers are driving the creation of private standards as they have first-hand information on consumers' preferences towards different product characteristics. Moreover, they have incentives in developing successful marketing strategies to communicate private label product attributes. However, consumer preferences are not the only factor affecting the retailers' decision of adopting private standards. The structure of the supply chain, the public minimum quality standard (MQS) set by the government and country-specific characteristics also play a fundamental role.

The creation and adoption of private standards has been studied from different points of view. First, many authors analyzed the effects that private standards have on producers and smallholders in developing countries. This literature is mainly based on case studies yielding opposite effects.[1] Second, another strand of literature analyzed the factors inducing companies to adopt private standards in the agri-food sector. These factors are firm-specific, and are conditioned by the socio-economic environment and by public policies. However, the majority of these studies provide qualitative analyses and their findings are mainly confined to specific case studies (García Martinez and Poole, 2004; Mainville *et al.*, 2005; Codron *et al.*, 2005). Third, some authors rely on the organizational innovation theory to analyze the determinants of the adoption of private standards at the international level. Within this literature, Neumayer

[1] For a review of this literature see Maertens *et al*. (2011).

and Perkins (2005) and Herzfeld *et al*. (2011) show that established trade relations and historical links with home countries, as well as infrastructure endowment and institutional factors are important determinants of the adoption of private standards by firms and farms.

Among the different product characteristics, the presence of ingredients obtained by genetic modification has attracted consumers' attention. Despite the fact that genetically modified (GM) crops are successfully adopted worldwide, many NGOs and green organizations in developed countries argue that GM crops can have negative effects on the agricultural production system in developing countries and that their effects on the environment and health are still unclear (Takeshima and Gruère, 2011), affecting the consumers' willingness to buy products containing GM ingredients. As a response to the demand for differentiated products not containing GM ingredients, in the middle of the nineties some European retailers started to adopt certified GM-*free* private standards, selling private label products not containing ingredients obtained from GM crops. GM-*free* standards are now increasingly spread worldwide.

Specific studies on GM food private standards are provided by Gruère (2006) and Gruère and Sengupta (2009). The first provides important insights on the role of the public regulation in ensuring to consumers the 'right to choose' among different products in supermarkets; the second studies the effects of GM-*free* private standards on policy decisions in developing countries. However, none of these two studies provide quantitative evidences, neither do they explain why retailers may decide to adopt GM-*free* private standards.

This paper aims to empirically analyze the factors affecting the retailers' decision of adopting GM-*free* private standards, an issue largely ignored in the present literature on private standards. Our analysis contributes to this literature in different ways. First, we obtained an original sample of GM private standards for 44 retailers operating in 54 countries distributed in all the continents. Second, using this wide sample we tested the hypotheses highlighted by the empirical literature using a binary response model. We found that historical, geographical, infrastructure and trade conditions significantly affect the retailer decision in adopting GM-*free* private standards. Finally, we also tested additional hypotheses formulated by the theoretical literature on vertical differentiation, and the political economy of private standard formation and of mass media. Our results show that public ownership of media reduces the likelihood that retailers adopt GM-*free* standards. On the contrary, different biotech regulations between the home and operating country increase the probability of the adoption of GM-*free* standards by the retailer.

The remainder of the paper is organized as follows. In section 2 we review the theoretical literature explaining the formation of private standards and the political economy of mass media. In section 3 we present and discuss our original sample on retailers' GM private standards. In sections 4 and 5 we provide hypotheses from the empirical literature and we explain the variables and methodology used in the econometric analysis. Section 6 provides the results and discusses the major findings. Finally, section 7 concludes.

2. Theoretical background

The theoretical analyses of the strategic adoption of private standards by firms follow two main approaches. The first approach uses vertical differentiation models analyzing the interaction between retailers and producers to explain the incentives of introducing private standards in the supply chain. In these models, alliances and bargaining processes in the supply chain are a tool to soften the price competition between retailers and to increase profits by product quality differentiation (Spence, 1976). These alliances enhance private standards depending on the structure of the production sector and of the supply market. Von Schlippenbach and Teichmann (2012) provide important explanations of the interactions along the supply chain. In their study, private standards are a tool to improve the retailers' bargaining position with respect to producers. In the vertical structure, one retailer sets a relatively high private quality standard, while a second retailer has an incentive to undercut its private quality standard such that the supplier complying with the lower quality standard loses its outside option, and *vice versa*. The result is an improved bargaining position of the low-quality retailer. The vertical differentiation approach is particularly relevant in the case of GM-*free* standards, given that the supply of non-GM ingredients is conditional to identity preserved (IP) supply channels, which are driven by supply contracts and product quality certifications.

The second approach focuses on the interaction between firm's and government's regulations, comparing the welfare effects of public vs. private standards. Private standards are strategically used by firms to preempt government regulations and to induce low (and less costly) public minimum quality standards (MQS) (Maxwell *et al*., 2000; Lutz *et al*., 2000; McCluskey and Winfree, 2009), choosing the quality level that minimizes the negative effects on firm's revenues. Vandemoortele and Deconinck (2013) use a political economy model to show in which circumstances the retailer chooses a standard stricter than the public one. The decision depends on the retailer's market power and on the political influence of producers. Moreover, other factors affect the decision of the retailer, such as the possibility for the retailer to transfer a smaller rent and to shift the implementation cost to producers.

Further important factors affecting the retailers' decision of adopting private standards are consumer preferences and quality perception. McCluskey and Swinnen (2004) analyzed the political economy of mass media and the consumer's perception toward biotechnologies. They showed that mass media ownership in developed countries progressively shifted from public to private. As a consequence, mass media objectives also shifted, from political to commercial objectives. The authors argue that private media tend to publish negative aspects of news items in order to maximize their profit, according to the "bad news hypothesis" - i.e. the marginal value of a piece of information with negative welfare effects is higher than the marginal value of a piece of information with positive welfare effects. Thus, private media are more likely to deliver potential risks associated with biotechnology rather than potential benefits, affecting the consumers' perception of products obtained with this technology. Curtis *et al*. (2008) show that differences in media organization and media consumption between developed and developing countries can explain the differences in consumer attitudes toward GMOs, *ceteris paribus*. They argue that the higher cost of information in developing countries, and the consequent lower consumption of information on biotechnology, can induce more favorable consumer's perception of GMOs.[2] The reason behind is that media in developing countries are often controlled by governments and the ideological influence of governments can increase the positive coverage of information in order to lower the risk perception of consumers.

The central aim of our analysis is to test the main hypotheses of the above-mentioned theoretical literature. Specifically, the effects of the interactions between retailers and producers will be tested using the ratio between the agricultural value added and the food value added. We expect that a greater participation of the producers in the food value chain promotes the adoption of GM-*free* private standards. Second, the influence of the mass media structure on private GMO standards will be also taken into account. In this respect, we expect that the public ownership of mass media provides less incentives in delivering 'bad news', reducing consumers' aversion to biotechnology, and, in turn, reducing the incentive for the retailer in adopting GM-*free* private standards. Finally, the interaction retailer-government will be tested by accounting for differences in the level of restrictiveness of public GMO standards. A strong heterogeneity in the public GMO regulation between the home country and the country where the retailer operates may induce the adoption of the private GM-*free* standard to overcome

[2] Kalaitzandonakes *et al*. (2004) provide evidence on the media coverage of biotech food in two rich markets, the Netherlands and the US. The authors show that in both markets media were generally negatively reporting on the potential health risks of biotech food, despite the fact that these risks were not confirmed.

negative effects on retailers' revenues due to different levels of public standards across countries.

3. Retailers' private GMO standards

3.1 Sample selection

We collected an original sample of GMO private standards for 44 retailers groups, consisting of 174 different supermarket brands that include all types of stores, from hypermarkets to express stores. Our sample represents about 74% of the world food retailers, ranked according to the value of retail sales in 2008 (Deloitte, 2009). Table 1 reports the complete list of retailers in the sample.

We collected publicly available retailers' statements on their global GMO policies, applying three different strategies in gathering data. First, we collected retailers statements contained in annual financial and sustainability reports of the year 2009 (published in 2010) or of the closest year available. Second, we collected similar statements from retailers' web pages accessed in the period between April and July 2010. Finally, we contacted the retailers' customer services in the same period, asking for explanation of unclear statements and for missing information.

The focus of the sample is on GM-*free* standards on private label products, which represent a direct link between supermarkets and suppliers. Organic products are not treated in the sample, assuming that they are all GM-*free* being subject to certification processes that do not allow for the use of GM ingredients.

We distinguished between countries where the retailer groups are based (home country) and countries where the retailer groups have stores (operating country). Retailers are concentrated in 12 home countries. 26 retailer groups are based in Europe, 16 in North America and 2 in Oceania. The overall 44 retailers have stores in 53 countries distributed over all the continents.

Table 2 shows the geographical distribution of our countries. Almost half of them are developing or emerging, largely located in Asia and Latin America.

European retailers have a wider geographical diffusion with stores in 44 countries. The high internationalization of European retailers can be due to the internal market structure as well as to historical factors such as past colonial expansion.

In contrast, North American retailers are mainly focused on their domestic markets, since they are present in only 15 countries of which 7 in South and Central America. North American retailers can rely on a larger domestic market, which reduces internal competition and the need of internationalization as a growth strategy.

Note that each retailer may have different standards in the different countries where it operates. Retailers do not always explicitly provide information on differentiated standards in the different markets (see next section for examples on standards' differentiation) hence we assume that the global standard is applied in those cases where a more specific standard is not indicated[3].

3.2 Retailers' private GMO standards

We divided the sample of retailers into three categories (see Table 3). Category 1 includes retailers not adopting GMO private standards and showing no objections to the use of GM ingredients. In the second category, retailers do not have a specific GM-*free* standard, but they do not label their products as "Containing GMOs", following the country's regulation on labeling threshold. This means that the retailers in category 2 can (potentially) made use of GM ingredients, but in quantities below the labeling threshold, so that no label is needed, even in a mandatory labeling regime. In the third category we include retailers stating not to use GM

[3] In some situation, different standards may be applied even at regional level. For example, Edeka does not have a common policy for Germany. The policy differs by region as Edeka is divided in South, North, West and East Germany.

ingredients in their private label products (GM-*free*). Not all the retailers in this category use GM-*free* labels. Indeed, many retailers are reticent in committing with GM-*free* labels, even if they rely on non-GM IP supply chains to ensure non-GM ingredients in their products.[4]

The world top ten retailers included in our sample are divided over the categories 'GM-*free*' and 'potential use of GM ingredients'. None of them are oriented to the use of GM ingredients. Only 3 retailers state that they do not have objections to the responsible use of GM ingredients. Two of them (Safeway and Kesko) operate only on the local markets, suggesting that their decision is closely linked to local consumers' preferences. The third (Koninklijie Ahold) operates in the Netherlands and in the US, that are more open to the use of GMOs. Moreover, the Ahold's position on GM ingredients takes into account the local regulations (see Table 4), adapting its strategy to the consumers preferences in the different countries.

Retailers in category 2 are 20 and the largest majority of them are based in North America[5]. Their behavior is particularly sensitive. Many retailers are not willing to take a defined position on GMOs - i.e. adopting GM-*free* labels - because of uncertainties both on the supply and on the demand side. On the one hand, the firm who adopts the GM-*free* label must purchase constant amounts of non-GM IP ingredients from one year to the other, and this is not easy to achieve on the traditional markets. To be provided with constant amounts of non-GM IP ingredients, the firm must create new and reliable supply channels that are conditional on business-to-business contracts and on certifications. Moreover, these supply channels increase economic and logistic burdens due to IP and products traceability. On the other hand, the label "Containing GMOs" can be perceived by consumers as a hazard warning, even if the GM

[4] In order to provide a more comprehensive picture, we decided to collect retailers' internal policies statements rather than the simple adoption of GM-*free* labels, because the latter can show only partial GM-*free* private strategies.

[5] Using the same methodology described in Section 3.1, we also checked the attitude on the use of GM ingredients of some major food multinationals (Nestlé, Kraft, Unilever and PespiCo) and fast-food restaurants (Mc Donald's, Starbucks and Pizza Hut). Both food multinationals and fast-food restaurants fall under category two. In particular, fast food restaurants are more consumers oriented, explicitly declaring that the major factor driving their GM standards is consumers' preferences. For example, Mc Donald's uses GM-*free* ingredients in its European restaurants, while it does not apply this standard in the US.

ingredients have been approved by the regulatory institutions after a health and environmental risk assessment. This warning effect can affect not only the sales of the labeled product, but also the consumer's perception of the overall retailer's "way to do business". Hence, many retailers prefer to remain on the "safe side", continuing to purchase the ingredients for their private label products on the traditional market and building the consumer's confidence relying on the public regulation remaining below the labeling threshold (Tillie *et al*., 2012).[6]

Moreover, there is a substantial difference in labeling GM-*free* animal products such as meat, eggs and dairy rather than plant products such as fresh produce and cooking oil made from corn and soybeans. While the latter may directly contain detectable GMO traces, the former consists of products from animals fed with non-GM feed, and it is impossible to detect GMO traces in the final product. Therefore, the certification for labeling animal products relies exclusively on the segregation of the supply chain. This involves more actors (from the collection, transportation, storage and compound feed sectors), each of them representing a potential source of admixture between GM and non-GM grains and subject to laboratory analyses to check compliance with non-GM requirements.

Retailers who have a GM-*free* standard (category 3) are 21, the large majority of them based in Europe. European retailers have driven the adoption of GM-*free* labels since the early 2000s. In 2004 Austria and Germany adopted the *Gentechnik-frei erzeugt* (GM-*free* produce) label for animal products, like dairy, poultry and pork, which progressively spread to other EU countries. In 2008 Germany enforced the *EGGenTDurchfG* Act that provided a legal base to GM-*free* labels[7]. More recently, in January 2012, France adopted a new decree (*Sans OGM*) that

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[6] The threshold established by the European regulation (above which a product must be labeled as containing GMOs) is 0.9%, while it is 1% in China, Australia and Brazil, 3% in South Korea and Malaysia, and 5% in Japan and Indonesia. The US and Canada have a voluntary labeling regime.

[7] The German Law on the Execution of Genetic Engineering, i.e. EG-Gentechnik-Durchfuehrungsgesetz (EGGenTDurchfG), was emitted in 2004 as implementation of the EU regulation 1829/2003/EG. However, only in 2008 food products could be labelled as GM-*free* (Ohne Gentechnik) under the EGGenTDurchfG act.

establishes rules for GM-*free* labels at national level. These two regulations will likely boost the adoption of GM-*free* labels also in other European countries.

The fact that most European retailers have a GM-*free* standard and that the European retailers included in category 2 remain below the 0.9% threshold suggests that GM private standards in Europe are stricter than public ones, in line with the theoretical findings of Vandemoortele and Deconinck (2013). However, this is not the case for North American retailers. According to the public regulation, US and Canadian supermarkets do not adopt specific standards on GM ingredients.

As already mentioned in the previous section, retailers' private standards may change in different markets, adopting the best strategy according to consumer preferences and public standards. For example, Tesco, which has its core business in Europe, adopts a GM-*free* standard globally, but with the exception of China and US where Tesco allows the use of GM ingredients (Table 4). In the same way, Delhaize avoids adopting specific GM standards, except in Europe where it adopts a GM-*free* private label.

Finally, some retailers belonging to the same group apply different approaches. For example, the Walmart Group has stores all over the world, but only in the UK a GM-*free* standard was implemented under the brand of ASDA. DIA, which is part of the Carrefour Group, declares to comply with public regulation while Carrefour sells GM-*free* private label products. Similarly, while Ahold global position is rather open to biotechnologies, the Ahold's joint venture Jerónimo Martins, with stores in Poland and Portugal, has a GM-*free* standard.

4. Hypotheses and data description

From the sample described above, we developed a binary dependent variable based on the retailers' statement about GMO private standards. While the meaning of a GM-*free* standard is straightforward, for the empirical analysis the distinction between category 1 ‘no objection to GMOs’ and 2 ‘potential adoption of GMOs’ is not similarly relevant, given that both may imply the use of GM ingredients, at least in very low quantities below the threshold level. Hence, we combined the sample into two groups: retailers adopting GM-*free* standards and retailers not doing it. The resulting categorical variable is called *GM-free* and describes the behavior of the retailer concerning GMO private standards in the countries where he has stores, hence the unit of our analysis is the pair retailer-country. The dependent variable takes value equal to 1 if the retailer uses GM-*free* ingredients in private label products in the country; and 0 otherwise.

The explanatory variables are selected on the basis of the theoretical and empirical literature. Following Herzfeld *et al*. (2011), we selected four country’s characteristics potentially influencing the retailer’s choice to adopt GM-*free* standards: historical and geographical conditions, infrastructures, sectorial conditions and the quality of institutions and economic development. Table 5 reports summary statistics of the variables used.

Historical and geographical factors affect cultural characteristics and information flows between countries, affecting, in turn, consumers’ preferences and firms’ behavior. Moreover, these factors may ease the transfer of new technologies and standards explaining their potential adoption (Neumayer and Perkins, 2005). To test for historical and geographical conditions, we used two variables. First, a dummy variable on *Common language* to control for cultural and historical factors, equal to 1 if home and operating country share the official language. We expect that sharing the official language increases the likelihood of the adoption of the standard, due to easier transfer of the standard from one country to the other. Second, we control for the country size using the logarithm of the population (*Population*). The common language dummy variable is taken from the CEPII Gravity dataset developed by Head *et al*. (2010); while the data on population is from the World Bank’s WDI database.

Infrastructure factors may affect the adoption of a private standard in different ways. On the one hand, the country's provision of transport infrastructure affects internal and export transports costs, influencing firms' competitiveness both on the domestic and on the international markets. Moreover, the provision of transportation infrastructure affects the costs of segregation between GM and non-GM products carried by the retailer. On the other hand, information and communication infrastructures are vital to access information on export requirements and on competitiveness strategies of other firms (Herzfeld *et al*., 2011). Access to telephones, faxes, e-mail and internet increases the likelihood of interactions between adopters and potential adopters in different countries, promoting the global diffusion of business strategies and standards (Neumayer and Perkins, 2005). The development of the country transportation infrastructures is taken into account using the *Road* density per square kilometer (WDI), while we use the *Telephone* lines per 100 people (WDI) as a proxy for information and communication infrastructures.

Sectorial characteristics are mainly captured by the country position on the international markets. International trade is not only a mean for the exchange of goods and services, but also a source of networks enhancing the transfer of knowledge and new practices. We used three variables. First, the agricultural export share (*Agexpsh*) that measures the relative importance of agricultural exports with respect to total exports. Countries with well-established agricultural exports have greater integration in the international market and higher comparative advantage in agricultural production (Herzfeld *et al*., 2011). Second, given that intense trade relations can induce homogenous organizational practices (Neumayer and Perkins, 2005), we use the logarithm of the agricultural bilateral exports (*Agbilexp*) between home and operating country. Finally, the share of agricultural products export on total exports to the European Union, the US and Japan (*AgexpEUJ*). These markets are highly competitive, promoting product differentiation strategies across retailers. Moreover, the high-income consumers can be more willing to pay a price premium for higher-quality differentiated products (Gruère *et al*., 2009). Trade data are from the UN COMTRADE, through the WITS service provided by the World Bank. In order to avoid endogeneity bias, the trade variables are calculated for the year 1995, prior to the introduction of the first commercial GM crop in 1996[8].

The fourth factor, the institutional environment, can shape market characteristics influencing the retailer behavior. To control the role of public institutions we used the *Rule of law* index, from the World Bank Governance Indicators database (see Kaufmann *et al*., 2007). This index indicates the effectiveness and the predictability of the judiciary system and the enforceability of contracts. It ranges between 0 and 5, with higher values for higher institutions quality. Empirical evidences suggest that quality management systems at firm-level are fostered by high-quality institutional environment (Correa *et al*., 2008), hence, similarly, we expect that better institutions encourage the adoption of the private standard.

Following Herzfeld *et al*. (2011), we also used the logarithm of the GDP per capita (*GDPpc*) to control for the level of economic development. For retailers in developing countries there can be potential disadvantages in adopting private standards due to prohibitive transaction costs. We tested also a possible non-linear relationship of the level of the economic development using the squared logarithm of the GDP per capita (*GDPpc2*).

In addition to the above variables proposed by Herzfeld *et al*. (2011), we also used a set of variables particularly relevant for the analysis of GM-*free* private standards.

First we used a variable on the presence in the country of green NGOs. Their campaigns can influence the preferences of consumers (Gruère *et al*., 2009), and, as a consequence, the decision of the retailer to adopt GM-*free* private standards. We considered two major green NGOs particularly active on anti-GMOs campaigns: “Greenpeace” and “Friends of the Earth”.

[8] The first commercially grown GM crop was the Flavr Savr tomato of the Calgene Company in 1994, but its diffusion was limited. The first extensive GM crop appeared in 1996, and it was the Roundup Ready herbicide-tolerant soybean of the Monsanto Company.

The variable is equal to 0 if none of the two is present in the country; 1 if only one is present and 2 if both are present.

Second, to control for the structure of the supply chain and for the bargaining power among producers and retailers (von Schlippenbach and Teichmann, 2012), we used the variable *Value added*, calculated as the ratio between agricultural value-added and food value-added (WDI). A common interpretation for this ratio is that lower values measure the 'maturity' of the agri-food sector and, other things been equal, it is affected by the country economic development (European Commission, 2009). Developing countries often have higher values of this ratio, because in the initial steps of the development process their agricultural value-added grows at higher rates than their food industry value-added, and *vice-versa* in more developed countries. In our model we directly control for the level of development using the GDP per capita, hence the *Value added* variable captures its differential effect, which is the repartition of the value-added along the supply chain. Since we control for development, higher *Value added* indicates that the agricultural sector has greater participation in the creation of value along the food chain. This increased role of the primary agricultural commodities in the food value-chain results in the primary sector's greater bargaining power, thanks to better organization of the farmers, to the production of higher quantities or quality (e.g. organic; fresh produce), or to the specialization in niche products (European Commission, 2009).

Third, we tested the hypotheses formulated by the theoretical literature on the political economy of mass media using the share of the public press on total press (*Press*) taken from Djankov *et al*. (2003). Vigani and Olper (2013) show that in rich countries, the competition between commercial media induces information bias on food safety issues that translates into a policy bias, namely more stringent GMO standards. According to the theoretical arguments of Curtis *et al*. (2008) and the empirical evidences of Vigani and Olper (2013), we expect that a higher share of public press would negatively affect the adoption of GM-*free* private standards.

Fourth, we relaxed the assumption made in Section 3.1 that the retailers adopt the global standard in all the countries where it has stores, adding two variables. The first, *Internationalization*, consists in the number of countries where the retailer has stores. It controls both for the level of international competitiveness of the retailer and for the probability that, at increasing number of countries, he adopts different standards to satisfy different consumers' preferences. The second, *Heterogeneous standards*, is a variable equal to 1 when we have the information that the retailer adopts different GM standards in at least one country; and 0 otherwise. This variable controls for unobserved heterogeneous standards for those retailers of which we have a proof they use different standards.

Finally, in order to account for the interaction between private and public GMO standards, we used an index on the restrictiveness of the GMO public regulation (*GMO index*), developed by Vigani *et al*. (2012) and Vigani and Olper (2013). The GMO index ranges between 0 and 1, where higher values indicate a more restrictive GMO regulation. We computed a regulatory distance between countries, obtained as the absolute deviation of the GMO index between the home (*i*) and the operating country (*j*), namely $GMO_{ij} = |GMO_i - GMO_j|$. We expect that higher heterogeneity in regulation between countries induces the retailer to adopt the private standard in order to choose the quality level that minimizes the negative effects on costs and revenues (McCluskey and Winfree, 2009). Moreover, different levels in the restrictiveness of the regulation may increase the incentives of the retailer to not use GM ingredients in order to avoid product transfer interruptions due to asynchronous and asymmetric approvals.

Because the GMO index may suffer of causality issues (the public standard may influence the adoption of the private standard, *vice versa* the presence of private standards on the markets may influence the formation of public standards), the *GMO index* will be treated as endogenous and instrumented with the GMO index of the five neighboring countries weighted by the distance (see Vigani *et al*. 2012).

With the exception of trade and *GMO index* variables, all the other explanatory variables are taken for the year 2005 (or closest). This lagged period with respect to the dependent variable, which refers to information we collected in 2010, allows us to clean for further potential endogeneity issues.

5. Econometric strategy

To explain the retailers' choice between different GMO private standards we used a binary response model to measure the retailer's probability to opt for the GM-*free* private standard, taking into account the country's characteristics.

The dependent variable y_{ij}, can take on the following values:

$y_{ij} = 1$ if the i^{th} retailer in the j^{th} country chooses a GM-*free* standard;

$y_{ij} = 0$ otherwise.

The binary response probability is given by:

$$P(y_{ij}=1|\mathbf{x}) = G(\beta_o+\beta_1 x_{ij}+\ldots+\beta_{16} x_{ij})+\varepsilon_{ij} = G(\beta_0+\mathbf{x\beta}) \quad (1)$$

Where $\boldsymbol{\beta}$ is a vector of coefficients to be estimated and $\mathbf{x}$ represents a vector of country j characteristics. Equation 1 is estimated using a Probit model, with maximum likelihood estimators (MLE), where the probability of the retailer i to adopt a GM-*free* standard in the country j depends on all the exogenous variables that describe the countries' characteristics.

We tested three different specifications of this model. The first specification includes in the vector $\mathbf{x}$ the following variables: (1) *Common language*; (2) *Population*; (3) *Road*; (4) *Telephone*; (5) *Agexpsh*; (6) *Agbilexp*; (7) *AgexpEUJ*; (8) *Rule of law*; (9) *GDPpc*; (10) *GDPpc2*; (11) *Green*; (12) *Value added* and (13) *Press*. The selection of these variables relies on the hypotheses on the probability of adopting GM-*free* standards discussed in the previous section.

In the second and third specification we augmented the vector **x** by adding the variables (14) *Internationalization* and (15) *Heterogeneous strategy*. The inclusion of these two variables allowed controlling for specific limitations of our sample. Since it was not always possible to collect information on each retailer brand in each country and we had to rely on retailers' global statements, we control for unobserved heterogeneity in the GM-*free* standard of retailers with these two variables.

In the third specification we added also the bilateral variable (16) *GMO index*, to observe the probability that different public standards across countries affect the adoption of GM-*free* private standards by retailers. As underlined in the theoretical literature, the use of private standards is linked to the level of public standards. However, public standards can be different between the home and operating country, affecting the retailer strategy in adopting private standards.

The same theoretical literature highlights that private standards are strategically used by firms to influence the output of the government in setting public standards. Because of this double causality influence between public and private standards, we also estimated Equation 1 using an instrumental variable Probit (IV Probit). In order to account for the potential endogeneity bias of the *GMO index*, we used the GMO index of the five neighboring countries weighted by the distance as an instrument.

Finally, in all the specifications we included regional dummies (for EU countries, Asia, Latin America, North America and Middle East) to control for any other omitted factors.

6. Results and discussion

The results of the econometric model are shown in Table 6. Overall, the magnitude of the coefficients and the marginal probability effects are consistent across specifications, thus the results of columns 1, 2 and 3 tend to confirm the stability of the basic model. Similar effects can be detected in column 4, where using IV Probit we account for potential endogeneity of the *GMO index*.[9] Overall, the majority of the hypotheses developed in Section 4 are confirmed, in particular the important role of the structure of the media sector and of the public policies in the adoption of GM-*free* private standards by retailers.

Starting from historical and geographical variables, in columns 1, 2 and 3 we find that when the home and operating country have common language, the likelihood that the retailer adopts a GM-*free* standard increases of about 22-24%. The common language enhances the spread of the standard, both as a result of easier transfer of new commercial strategies and of shared consumers and firms characteristics. In contrast, in columns 1 and 2 the country size has a significant negative effect on the likelihood of adopting GM-*free* private standards. This can be due to a more complex stratification of the (large) population that makes difficult to identify clear standards preferences.

Looking at the results of infrastructure variables, we obtain deeper understanding of the effect of the country size. In column 1, a higher share of *Roads* reduces the likelihood of adopting GM-*free* standards. Each additional km of roads for squared km reduces the likelihood of adopting GM-*free* private standards of about 10%. The negative effect found on *Road* is in line with the result of Herzfeld *et al.* (2011) that used a similar variable to study the adoption of

[9] We used two tests for checking for potential endogeneity of the GMO index in specification 3. Because the theory of the diagnostics is not developed for IV Probit or any other nonlinear model, we report tests results for the corresponding linear probability model, since instruments for diagnostics are a property of the first stage, which is common both to IV linear and non-linear estimators. The first test is the Durbin-Wu-Hausman (DWH), which tests for the consistency of the model. Its null-hypothesis is that the coefficient of residuals of endogenous variable is 0. From the results of the DWH test, we reject at 1% significance level the null-hypothesis that *GMO index* is exogenous, hence the OLS estimator is not consistent. Second, we used the Endogeneity test provided by the STATA command ivreg2 (defined as the difference of two Sargan-Hansen statistics). The null hypothesis is that the specified endogenous regressors can actually be treated as exogenous. We reject the null-hypothesis at 1% level, confirming that the *GMO index* must be treated as endogenous.

GlobalGAP certificates by countries. However, this effect loses significance in specification (2) and (3). Thus, we have only weak evidences that a more complex infrastructure (in particular in large countries) can reduce the incentive of adopting a GM-*free* standard due to higher compliance costs of segregation measures. In contrast, a greater endowment of information infrastructure, such as telephone lines, significantly increases the likelihood of adopting a GM-*free* standard, confirming the hypothesis that more information facilities enhance the firm's integration on the international competitive markets. The variable *Telephone* is significant at 1% level in all the specifications.

The next group of variables suggests that the country trade position can be an important factor affecting the retailer's decision of adopting GM-*free* standards. In particular, high trade flows between home and operating country have a negative effect on the probability of adopting GM-*free* standards, even though with a small marginal effect. The *Agbilexp* variable is always negative and significant at 5 or 10% in columns 1 and 4 respectively. Indeed, well established trade relationships may oppose the introduction of a standard that increases trade costs due to IP chains. On the contrary, the country comparative advantage in exporting agricultural products and the higher share of agricultural exports to rich markets (i.e. European Union, Japan and the US) do not seem to have a decisive role in driving the adoption of GM-*free* private standards.

None of the results on the quality of institutions, the level of development and the presence of green NGOs are statistically confirmed, while the role of the value chain and of the public press yielded important results.

The variable *Value added* is positive and significant at 1% level in all specifications. With a larger share of agricultural value-added, the likelihood of adopting the GM-*free* standard increases from 15% to 24%, depending on the specification. This confirms our hypothesis and also the findings of the theoretical literature on vertical differentiation strategies (von

Schlippenbach and Teichmann, 2012). Better farmers organization and high-quality and niche productions, resulting in higher share of the overall value of the food chain and in greater bargaining position of upstream farmers, enhance producers to afford low productive and more costly GM-*free* productions (Wesseler *et al*., 2011), and to obtain production risks mitigation tools, such as supply contracts.

The hypotheses from the political economy of mass media are also confirmed. In all the specifications, results show that an increase in the public ownership of the domestic newspapers decreases the likelihood of adopting GM-*free* standards, and this effect is significant and particularly strong. This suggests that, since public media tend to transmit information with a less negative view with respect to private media in order to soften food safety concerns (Curtis *et al*., 2008), public media tend to lower the consumers' aversion towards GM products, reducing the incentives for retailers to sell GM-*free* products.

Retailers with higher level of internationalization and showing different private GM-*free* standards in different countries are less likely to adopt GM-*free* standards. The coefficients on *Internationalization* and *Heterogeneous strategy* are always negative and statistically significant in columns 2, 3 and 4. This suggests that if the retailer operates in numerous markets, its willingness to adopt restrictive GM private standards (implying greater segregation costs) is lower than for retailers dependent to smaller local markets.

Finally, we tested the effect of the difference in biotech regulation between the home and operating country. An increase in the regulatory difference between countries strongly increases the probability that the retailer adopts GM-*free* private standards. This result confirms the hypotheses of the theoretical literature on the interaction between private and public standards. In the presence of heterogeneous GMO regulations, the retailer is more likely to adopt its own private standard, setting the quality level that minimizes the negative effects on revenues. Moreover, in order to exploit their private label products in different markets, the best strategy is to sell products not containing GM ingredients. This allows the retailer to avoid problems such as asynchronous or asymmetric approval while transferring private label products from one country to the other, allowing exploiting the non-GM IP supply channel to a larger (international) scale, without incurring in different labeling thresholds. The adoption of a single (restrictive) private standard at large scale permits to overcome compliance and logistic costs due to different public MQS levels in different countries, obtaining homogeneous products for markets with different regulations.

7. Conclusions

This paper contributes to the empirical literature on private standards, investigating the determinants of the adoption of GM-*free* private standards by retailers.

First, we provide an original sample of GMOs private standards for 44 retailers, showing that these standards can be clustered into three groups: retailers not adopting GM-*free* standards; retailers following the public regulation on labeling threshold and retailers using GM-*free* private standards. Second, we tested four groups of variables from the theoretical and empirical literature on the private standard formation: historical and geographical factors; infrastructure; sectorial conditions and the quality of institutions and economic development. As key results, we found that a greater participation of the primary sector to the creation of value-added in the food chain induces the adoption of GM-*free* private standards. Moreover, a greater share of public media decreases the consumers' aversion towards GMOs, reducing the incentives for retailers to sell GM-*free* products. Finally, uncertainties at public regulation level, in the form of heterogeneous public standards between countries, induce the retailer to adopt private standards in order to voluntarily choose the quality level that minimizes the negative effects on revenues.

Besides identifying the factors inducing retailers to adopt GM-*free* standards, our results raise also important issues on the environmental and economic sustainability of these standards. First, the environmental effects of the GM-*free* production are questionable when the loss of the potential environmental benefits from GM crops is considered. GM crops can have important direct and indirect environmental benefits, especially for developing countries, such as the reduction of pesticide applications, lower pressure on land use and lower on-farm fuel consumption and greenhouse gas (GHG) emissions (Wesseler *et al*., 2011). All these environmental benefits are potentially lost in the GM-*free* production.

Second, market actors deciding to participate in the GM-*free* supply chain face two different sources of uncertainties, concerning commercial relationships and market stability.

In the first case, the sourcing of non-GM IP products by retailers requires long-term contracts for certified non-GM products and it is costly due to segregation measures, lower productivity and higher inputs use of non-GM crops. In front of these problems, the European retailers recently took two opposite strategies. The first strategy consists in reinforce the relationships with producers. For example, on May 2013, a group of 13 European retailers launched the initiative “Brussels Soy Declaration”, in order to support the Brazilian cultivation of GM-*free* soybean, reducing costs and creating a stronger link with Brazilian producers for the sourcing of GM-*free* products in the long run. In contrast, the second strategy is to reverse the private standard. Indeed, in the last two years several UK retailers (ASDA, Morrisons, Tesco, The Cooperative, Marks & Spencer and Sainsbury’s) abandoned their GM-*free* requirements on poultry products, because of the difficulties of UK farmers in sourcing enough GM-*free* feed. The abandoning of the GM-*free* standard was condemned by green groups, accusing the UK retailers of betray their promises to customers. Hence, GM-*free* private standards are abandoned because not sustainable in the long run, but at higher costs in terms of public image and creating unreliable commercial relationships with producers.

The second source of uncertainty, the market stability, derives from the possible shrink of the EU imports of GM-*free* protein crops. The EU is currently a net importer of non-GM soya, but the EU is seeking higher self-sufficiency through the recent reform of the CAP that included voluntary 'coupled' direct payments for protein crops. In Europe there are no authorized GM protein crops, hence any cultivable protein crop is non-GM, and the expected higher internal production of non-GM soya consequent to subsidization would reduce the EU demand for GM-*free* protein crops from foreign exporting countries.

What is most interesting is that all the above described scenarios have large economic impacts on both farmers and market actors in developing countries deciding to produce GM-*free*. On the one hand, farmers in developing countries can lose important economic benefits derived from the use of GM crops, such as increased yields and simplified crop management, and, consequently, lose important contribution toward food security. On the other hand, the creation of a non-GM supply chain generates fixed and variable costs for market actors in developing countries, potentially balanced by price-premiums and market access. Therefore, an unexpected break of the GM-*free* production (either due to companies abandoning the GM-*free* standard or to lower market demand) would provoke the effective loss of the investments on segregation and certification infrastructures.

Given the above mentioned economic and environmental effects of GM-*free* private standards, more research is needed in this field. In particular, the effects of the adoption of GM-*free* private standards by food multinationals and global fast food restaurants is widely ignored in the literature, despite the fact that these companies are vital in shaping the global agri-food supply and demand.

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Table 1: List of retailers groups and private GMO standards, ordered by retail sales according to Deloitte, 2009.

	Home Country	*Retailer*	*Main Markets*	*GMO Private Standard*
1	USA	Walmart	US, Latin America	Potential use of GM ingredients
2	FRA	Carrefour Group	Europe, Latin America	GM-*free*
3	DEU	Metro Group	Global	Potential use of GM ingredients
4	GBR	Tesco	Global	GM-*free*
5	USA	The Kroger Company	US	Potential use of GM ingredients
6	DEU	Aldi Group	Europe, US	GM-*free*
7	DEU	Rewe Group	Germany, Austria	Potential use of GM ingredients
8	FRA	Auchan Group	Europe	GM-*free*
9	FRA	E. Leclerc	Europe	GM-*free*
10	DEU	Edeka Group	Germany	GM-*free*
11	USA	Safeway	North America	No objection to GM ingredients
12	FRA	Casino Group	Europe, Latin America	GM-*free*
13	NLD	Koninklijke Ahold	US, the Netherlands	No objection to GM ingredients
14	AUS	Woolworths	Oceania	Potential use of GM ingredients
15	USA	SuperValu	US	Potential use of GM ingredients
16	AUS	Coles Group	Australia	GM-*free*
17	GBR	J Sainsbury	UK	GM-*free*
18	GBR	Morrison Supermarkets	UK	GM-*free*
19	BEL	Delhaize "Le Lion"	US, Europe	Potential use of GM ingredients
20	FRA	Systeme U	France	GM-*free*
21	USA	Publix Supermarkets	US	Potential use of GM ingredients
22	CAN	Loblaw Companies	Canada	Potential use of GM ingredients
23	CHE	Migros Group	Switzerland	GM-*free*
24	ITA	COOP Italy	Italy	GM-*free*
25	GBR	Marks & Spencer	Global	GM-*free*
26	CHE	Coop Switzerland	Switzerland	GM-*free*
27	USA	Meijer	US	Potential use of GM ingredients
28	DEU	Tengelmann Group	Germany	GM-*free*
29	SWE	ICA Group	Sweden, Norway	Potential use of GM ingredients
30	FIN	Kesko	Finland	No objection to GM ingredients
31	USA	Dollar General	US	Potential use of GM ingredients
32	GBR	Somerfield Stores	UK	GM-*free*
33	USA	Giant Eagle	US	Potential use of GM ingredients
34	USA	Whole Foods Markets	US	GM-*free*
35	ITA	Esselunga	Italy	Potential use of GM ingredients
36	USA	Winn-Dixie	US	Potential use of GM ingredients
37	FRA	Cora Group	Europe	GM-*free*
38	USA	ShopRite	US	Potential use of GM ingredients
39	USA	Hyvee	US	Potential use of GM ingredients
40	ITA	Mdo	Italy	GM-*free*
41	USA	Roundy's Supermarkets	US	GM-*free*
42	USA	Nash Finch Company	US	Potential use of GM ingredients
43	ITA	Selex Group	Italy	Potential use of GM ingredients
44	CAN	Sobeys	Canada	GM-*free*

Source: own data collection. See text for explanation.

Table 2: Number of countries in the sample grouped in geographical regions.

Operating Markets	*Developing\Emerging*	*Developed*	*Tot*
Africa	1	0	1
Asia	8	2	10
Europe	5	21	26
Middle East	2	0	2
North America	0	2	2
Central America	4	0	4
South America	6	0	6
Oceania	0	2	2
Tot	**26**	**27**	**53**

Note: Classification based on the International Monetary Fund's World Economic Outlook Report, April 2012.

Table 3: Number of retailers grouped in GMO private standard and geographical regions.

Home	Numbers of Retailers		
	None objections to GM ingredients	Potential adoption of GM	GM-*free*
Europe	2	6	18
North America	1	13	2
Oceania	0	1	1
Total	3	20	21

Source: own data collection. See text for explanation.

Table 4 – Examples of retailers' statements on GMO private standards

Retailer	*Home Country*	*Statement on GMOs*	*Source*
ALDI Australia (ALDI Group)	Germany	"We have achieved 'green' status for our Genetically Modified (GM) policy in Greenpeace's True Food Guide. ALDI complies with all existing regulatory requirements pertaining to GM as stated in the Australia New Zealand Food Standards Code. ALDI does not stock any products which are labeled as containing GM ingredients."	ALDI Australia Website (accessed 28/05/2010)
DIA (Carrefour Group)	France	"…DIA complies with current legislation, guaranteeing that products do not consist of, nor have they been produced from, ingredients that contain more than 0.9% GMO. To guarantee its compliance, the company demands certificates from all its suppliers and carries out periodic analyses of all its products."	DIA Annual Report 2007
J Sainsbury	UK	"At Sainsbury's we do not permit the use of genetically modified crops, ingredients, additives or derivatives in our own-brand food, drink, pet food, dietary supplements and floral products. We work closely with our suppliers, who are subject to our strict approval and audit processes, to ensure that our GM policy is adhered to at every step of the supply chain. We require the supply chain to be identity preserved."	Media FAQs November 2009
Royal Ahold	Nederlands	"Where there are clear, demonstrable benefits to consumers, Ahold has no objections to the responsible use of safe biotechnology. Products we offer which are made with this technology are products which are approved by the authorities, based on a safety and environmental impact assessment. We differentiate our assortment from country to country in line with consumer demand."	Ahold Wbsite (accessed 07/04/2010)
Safeway	USA	"Today's agricultural and food industries are using genetic engineering to develop new and better foods and food-related products. [...] You may not be able to tell when you're buying GM foods, because the FDA generally doesn't require manufacturers and producers to label them as such. That's because GM foods are considered no different in quality or safety from conventionally produced foods."	Safeway Website (accessed 05/06/2010)
Tesco	UK	"We have a non-GM ingredient policy for our own-brand foods in 11 of the countries in which we operate.[…] In China and the US we do allow some GM ingredients in our own-brand products. In the US, due to high levels of GM soy and maize, it would be virtually impossible to segregate products according to whether they did or did not contain GM ingredients. "	Corporate Responsibility Report 2009

Table 5 – Summary statistics of dependent and independent variables.

Variable	Obs	Min	Max	Mean	Std. Dev.
Dependent:					
GM-free	338	0	1	0.57	0.50
Independent:					
Common language	338	0	1	0.11	0.31
Population	338	13.05	20.99	17.62	1.52
Road	338	0	4.96	1.01	0.91
Telephone	338	1	69.00	38.57	18.05
Agexpsh	338	0.01	0.91	0.20	0.17
Agbilexp	338	0	16.64	8.22	6.28
AgshEUJ	338	0.005	0.95	0.22	0.20
Rule of law	338	1.28	4.45	3.20	0.90
GDPpc	338	5.37	11.09	9.40	1.32
GDPpc2	338	28.79	123.07	90.00	23.13
Green	338	0	2	1.72	0.50
Value added	314	0.01	0.91	0.20	0.17
Press	313	0	1	0.04	0.19
Internationalization	338	1	23	11.79	7.00
Heterogeneous standards	338	0.32	0.47	0.32	0.47
GMO index	321	0	0.60	0.12	0.15
GMO index instrument	321	0	0.48	0.12	0.16

Note: See text for variables explanation.

Table 6 – Results from the Probit and IV Probit models.

Dependent: *GM-free*	(1)		(2)		(3)		(4)	
	Probit		Probit		Probit		IV Probit	
	Coeff.	dy/dx	Coeff.	dy/dx	Coeff.	dy/dx	Coeff.	dy/dx
Hist. and geogr. conditions								
Common language	0.788**	0.229	0.910**	0.241	0.833**	0.217	0.607	0.222
	(0.356)		(0.375)		(0.385)		(0.378)	
Population	-0.216*	-0.063	-0.226*	-0.060	-0.188	-0.049	-0.135	-0.053
	(0.116)		(0.128)		(0.126)		(0.119)	
Infrastructure								
Road	-0.333**	-0.097	-0.222	-0.059	-0.214	-0.056	-0.149	-0.059
	(0.138)		(0.141)		(0.141)		(0.139)	
Telephone	0.062***	0.018	0.075***	0.020	0.073***	0.019	0.054**	0.021
	(0.020)		(0.022)		(0.022)		(0.022)	
Trade								
Agexpsh	-3.859	-1.122	-4.303	-1.138	-3.124	-0.815	3.348	1.324
	(6.405)		(6.685)		(6.904)		(6.672)	
Agbilexp	-0.039**	-0.011	-0.006	-0.002	-0.015	-0.004	-0.035*	-0.014
	(0.017)		(0.019)		(0.019)		(0.019)	
AgshEUJ	1.690	0.491	2.121	0.561	0.673	0.176	-5.515	-2.181
	(5.084)		(5.348)		(5.554)		(5.422)	
Instit. quality and GDP pc								
Rule of law	-0.515	-0.150	-0.444	-0.118	-0.388	-0.101	-0.242	-0.096
	(0.326)		(0.343)		(0.348)		(0.330)	
GDPpc	0.817	0.238	2.068	0.547	2.137	0.558	2.496	0.987
	(2.202)		(2.338)		(2.300)		(2.188)	
GDPpc2	-0.068	-0.020	-0.152	-0.040	-0.150	-0.039	-0.153	-0.061
	(0.125)		(0.132)		(0.131)		(0.125)	
Additional variables								
Green	0.506	0.147	0.433	0.115	0.394	0.103	0.196	0.077
	(0.333)		(0.347)		(0.360)		(0.349)	
Value added	0.062***	0.018	0.057***	0.015	0.065***	0.017	0.060***	0.024
	(0.019)		(0.020)		(0.021)		(0.020)	
Press	-3.112***	-0.905	-3.448***	-0.912	-3.264***	-0.851	-2.117**	-0.837
	(0.895)		(0.942)		(0.979)		(0.998)	
Internationalization			-0.073***	-0.019	-0.073***	-0.019	-0.064***	-0.025
			(0.017)		(0.017)		(0.017)	
Heterogeneous standards			-0.473**	-0.125	-0.484**	-0.126	-0.551***	-0.217
			(0.202)		(0.201)		(0.196)	
GMO index					2.240*	0.584	6.677***	2.641
					(1.190)		(1.446)	
Constant	1.765		-2.596		-4.209		-7.972	
	(11.090)		(11.970)		(11.710)		(11.070)	
Regional fixed effects	YES		YES		YES		YES	
Log-likelihood	-151.360		-137.793		-134.984			
Pseudo R-sqared	0.251		0.318		0.328			
Observations	295		295		293		293	

*Note: In parentheses robust standard error. ***, ** and * indicate significance level at the 1%, 5% and 10%, respectively. Each regression includes regional fixed effects for Asia, the EU, Middle East, North and Latin America.*